Solar Heat for Industrial Production Processes - Latest Research and Large Scale Installations

Christoph Brunner

AEE – Institute for Sustainable Technologies (AEE INTEC)
A-8200 Gleisdorf, Feldgasse 19
AUSTRIA
Industrial heat has an important role in the global economy

Note: Figure based on 2009 data
Source: Energy Technology Perspectives 2012
ARENA Solar Process Heat WS
IEA Roadmap: Vision for solar heating and cooling (by sector in EJ/a)

solar process heat: 7,2 EJ/a

Source: IEA Technology Roadmap – Solar Heating & Cooling
Potential

- Potential of solar process heat <250°C

  - Austria: 1.5 TWh/a = 3.3 Mio. m² [Weiss, 2006]
  - Germany: 16 TWh/a = 36 Mio. m² [Lauterbach, 2011]
  - EU 25: ca. 70 TWh/a = 155 Mio. m² [Vannoni, 2008]
Temperature levels in different industries

Data for 2003, 32 Countries: EU25 + Bulgaria, Romania, Turkey, Croatia, Iceland, Norway and Switzerland.
Source: ECOHEATCOOL (IEE ALTENER Project), The European Heat Market, Work Package 1, Final Report published by Euroheat & Power
Temperature levels of processes

- Parabolic trough collectors
  - CPC collector
  - Vacuum tube collector
  - Flat plate collector

- Food industry
  - Cooking
  - Cleaning and washing
  - Evaporation and distillation
  - Pasteurisation

- Textile industry
  - Washing
  - Dyeing
  - Drying
  - Bleaching

- Surface treatment
  - Cleaning
  - Finishing
  - Surface treatment

- Chemical industry
  - Distillation
  - Extraction
  - Cocking

- All sectors
  - Preheating of processes
  - Heating of industry halls

Temperature levels:
- 100°C
- 200°C
- 300°C
Steps of energy efficiency analysis and implementation of renewable energy

Collection and measurements of energy relevant data, mass and energy balance, visualization of the production process with flow sheet and Sankey diagram

Technology optimization – use of energy efficient process technologies, optimized heat and mass transfer; lower the supply temperature

System optimization, energy efficient production, heat recovery, Pinch analysis, storage management

Implementation of renewable energy technologies; waste to energy, solar thermal energy, biomass
Minimum energy demand for heat and cold
Heat exchanger network
Design of heat storages
Optimum integration point for RES
Principles of system integration

Supply level

Process level
Integration Efficiency - Motivation

- Efficiency of storage
- Efficiency of heat exchanger after storage
- Efficiency of heat distribution
- Efficiency of heat exchanger within process
Pre-heating boiler feed water

- Raw water
- Condensate
- Make-up water
- Condensate tank
- Boiler feed water
- Condensate return
- Exhaust gas
- Steam line
- Degasification
- Q_{sol}

Source: Bastian Schmitt Uni Kassel
Integration concepts

- Solar heating of product or process media with external heat exchanger

Source: Bastian Schmitt Uni Kassel
Integration concepts

➢ Solar heating of intermediate hot water circuits with external heat exchanger
Integration concepts

- Solar heating of bath, machinery or tank with internal heat exchanger plates

Source: Bastian Schmitt Uni Kassel
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Overview collectors

«Large» Parabolic Troughs and Fresnel Collectors

250-450 °C

«Small» Parabolic Trough and Fresnel Collectors
High Vacuum Flat Plate Collectors
(Advanced) Evacuated Tube Collectors

120-250 °C

Evacuated tube Collectors, Advanced Flat Plate Collectors
CPC Collectors

80-120 °C

Standard Flat Plate Collectors

< 80 °C

Uncovered Collectors

< 40 °C

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Flat plate collectors

80-120 °C

www.schueco.com

www.solid.at
Vacuum tubes collectors

80-120 °C - 120-250 °C

www.kollektorfabrik.de

www.ritter-gruppe.com
Flat plate collectors with vacuum

80-120 °C

120-250 °C

www.srbenergy.com

www.tvpsolar.com
Parabolic trough collectors

120-250 °C

www.smirro.de

www.nep-solar.com
Fresnel collectors

120-250 °C

www.industrial-solar.de

www.chromasun.com
SHIP data base of realized plants
155 plants/ 144,406 m² collector area/ 101 MW

- 71 plants with 4,4 MW
- 20 plants with 73 MW

Area categories [m²]

Collector area [m²]

Number of plants [-]

- Summe der Brutto-Kollektorfläche [m²]
- Anzahl der Anlagen [-]
## Industry sectors

### Brutto collector area [m²]

- **Mining**
- **Food**
- **Textile incl. tanneries**
- **Beverage**
- **Chemical Industry**
- **Metal and machinery**
- **others**

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Heat Costs Comparison

- Useful heat from electricity
- Useful heat from natural gas
- District heating Central Europe
- Industrial process heat...
- Combi-systems Central /...
- DHW forced circulation...
- DHW thermosiphon...

Heat costs in €-cent / kWh

EU27 average: €-cent 19.3
EU27 average: €-cent 7.7

Quelle: ETP RHC (2013)
SHIP in Asia
China`s Solar Roadmap

- Since 2013, the space of solar industrial and agricultural thermal application system increased rapidly.
- By 2020, 1.5% of industrial and agricultural thermal demand will be supplied by solar thermal.
- During 2020-2030, there’ll be an annual increase of 12% of solar thermal industrial and agricultural application space;
- During 2030-2050, the annual increase will reach 6%.
China – high number of very large systems

- Foshan Jialida textiles Co. LTD.
  - Collector area: 3000 m²
  - Application: dyeing
  - Completion: 2006
- Shenzhen Qinger Solar Energy Co.

- Dali Textiles Co. LTD. Xinchang
  - Collector area: 13000 m²
  - Application: dyeing
  - Completion: 2008
- Shenzhen Qinger Solar Energy Co.
China – high number of very large systems

- Changshu printing and dyeing Co Ltd
- Collector area: 7460 m²
- Application: dyeing
- Completion: Sept. 2010
- Jiangsu Sunrain Solar Energy Co.
SHIP in South-America

Chile
World's largest solar field

**Process**
- Copper recovery process
- Electrolyte constant at 50°C
- Additionally cleaning processes

**Solar system**
- Sunmark
- 39,300 m² flat plate collectors
- 4,300 m³ storage
- 85-100% solarer fraction
World's largest solar field
SHIP in North-America

USA

Mexico
Mexico – parabolic trough collectors

- 6 installations from “Inventive Power”
  - Buenavista Greenhouse
  - La Doñita Dairy
  - Lácteos Covbars Dairy
  - Nutrición Marina (Food Pellets)
  - Matatlan Dairy
  - El Indio Dairy
USA: Prestige Food

Process

- Poultry-processing plant in North Carolina, USA
-ESCO: FLS Energy
- 568 m³ hot water each day (60 °C)
- Cleaning processes

Solar system

- In operation since 2012
- 7.804 m² flat plate collectors
- 852 m³ storage (10 x 85 m³)
- Solar fraction of hot water demand: 50%

Bildquellen: FLS Energy
SHIP in Europe

Italy, Switzerland, Germany, Austria
Swiss– milk processing in the focus

- **LESA (Lateria Engiadinaisa SA) in Bever**
  - 115m², heat contracting
  - 1700 altitude, high snow load

- **Emmi Group (Fromagerie Tête de Moine) in Saignelégier**
  - 627m², low temperatures to -20°C

- **Cremo SA in Fribourg**
  - 585m²
  - Assembled towards the south, unconventional tracking.
Germany - SolSteam

- Integrated system concept based on proven components
- Secure steam supply to the processes in the usual quality
- Fuel saving by solar steam generation
- Sharing of peripheral components
**Introduction to SolarBrew**

**PROJECT CONSORTIUM**
- AEE INTEC (coordinator)
- HEINEKEN Supply Chain B.V.
- GEA Brewery Systems GmbH
  - process engineering
- Sunmark A/S
  - solar engineering

**Solar Brew: Solar Brewing the Future**

*EU FP7 (2012 – 2015)*

Projekt Nr. 295660
ARENA Solar Process Heat WS

State of the project

BREWERY GOESS

- Solar assisted mashing process
- 1,470 m² ground mounted flat plate collector field
- 200 m³ pressurized hot water energy storage tank
- Commissioned: June 2013

4.6 million pints of beer per year brewed with the power from the sun*

* assuming 60 MJ thermal energy consumption per hl of beer in the brewery Goess
State of the project

BREWERY GOESS

- Construction of the 1,500m² solar thermal collector field
Summary for decision

- Check if your energy need is on the appropriate temperature level for solar thermal
- Energy efficiency first
- Willingness for potential changes in the process technology
- Important factors are the solar irradiation (shading), space availability and production times
- Pre-feasibility study with economical check
- Check of possibilities for Subsidies
- Cooperation between engineering company and solar company

- Green energy with a constant energy price
Thank you for your attention

Christoph Brunner

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